

A composite image showing a spacecraft in the foreground and the International Space Station in the background, both orbiting Earth. The Earth's surface is covered in blue oceans and white clouds. The spacecraft in the foreground has a white cylindrical body, gold-colored insulation, and two large solar panel arrays. The ISS in the background consists of a complex structure with multiple solar panel arrays and various modules.

**Department of Defense
Para-Rescue Jumpers
NASA Space Life Sciences
October 2009**



Mission Science Requirements Definition

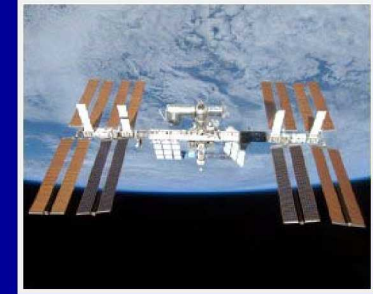


The requirements to conduct scientific research in support of human space exploration are defined in the:

- **NASA Strategic Plan, NASA Policy Directive (NPD) 1001.0**
- **Exploration Architecture Requirements Document (ESMD-EARD- 08-07)**
- **NASA Space Flight Human System Standard – Volume 1 (NASA-STD- 3001)**
- **NASA Human Research Project, Project Plan, HRP-47051 Revision A 2**



Mission Objectives



- **Provide for crew health and safety**
- **Understand the effects of the space environment on human performance for long-duration human space exploration**
- **Provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration**
- **Enable the definition and improvement of human spaceflight medical, environmental, and human factors standards**
- **Evaluate the concept of operations for exploration class missions**



Mission Science Requirements Definition



Interdisciplinary Approach

Bone Loss

Cardiovascular Alterations

Environmental Health

Immunology & Infection

Skeletal Muscle Alterations

Sensory-Motor Adaptation

Space Medicine

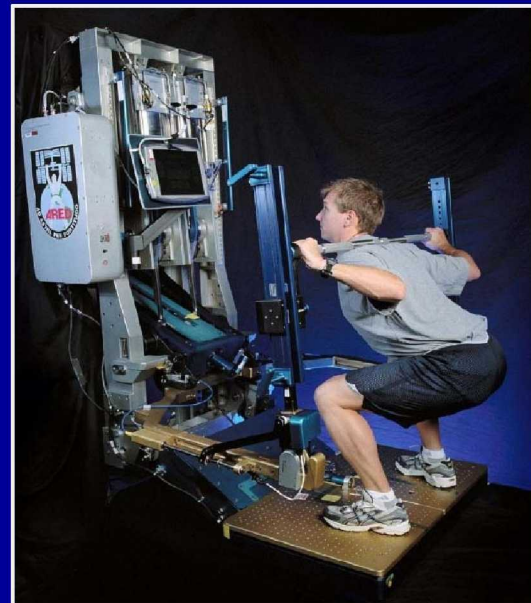
Nutrition

Clinical Capabilities

Behavioral Health & Performance

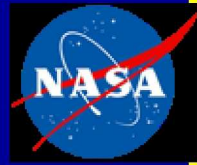
Human Factors

Radiation

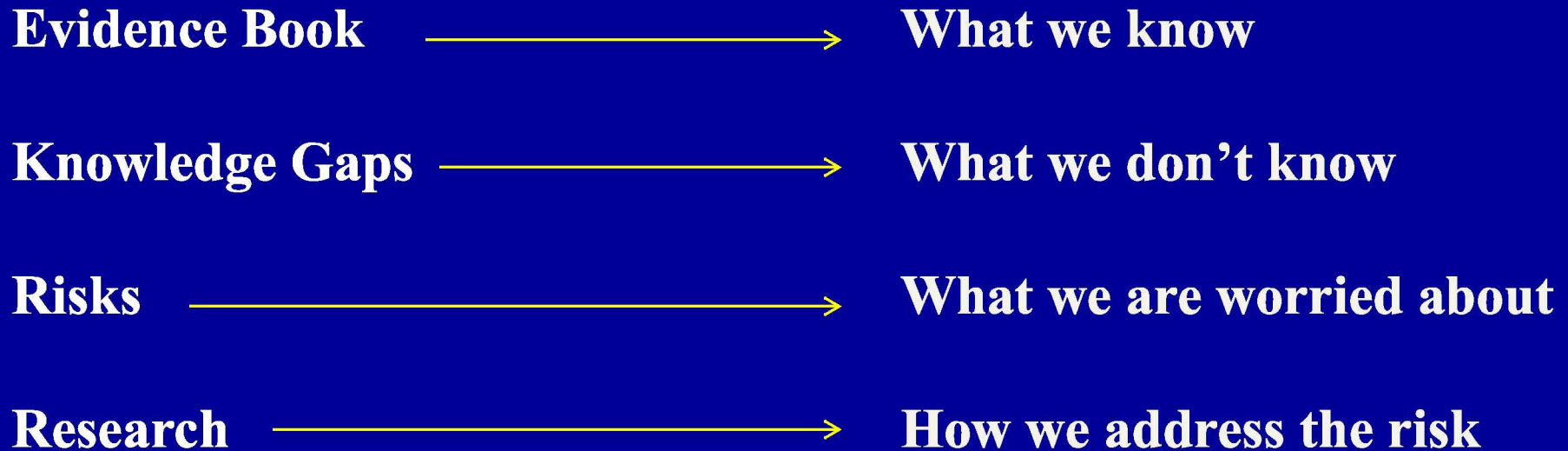




Mission Requirements Definition



Why we do what we do...



Master plan to close risk for exploration



Mission Science

Example Risks for Exploration Missions

- Risk of Accelerated Osteoporosis
- Risk of Acute or Late Central Nervous System Effects from Radiation Exposure
- Risk of Adverse Health Effects from Lunar Dust Exposure
- Risk of Behavioral and Psychiatric Conditions
- Risk of Bone Fracture
- Risk of Cardiac Rhythm Problems
- Risk of Crew Adverse Health Event due to Altered Immune Response
- Risk of Degenerative Tissue or Other Health Effects from Radiation Exposure
- Risk of Impaired Performance due to Reduced Muscle Mass, Strength, and Endurance
- Risk of Intervertebral Disk Damage
- Risk of Orthostatic Intolerance during Re-Exposure to Gravity
- Risk of Renal Stone Formation

**Responsibilities for crew health extend beyond the mission
and include the potential for lifetime risk**





Postflight R+0 Medical Requirements

MEDB 1.1	Clinical Assessment	1.00	R+0
MEDB 1.4	Neurological Assessment	1.00	R+0
MEDB 1.6	Resting ECG	0.25	R+0/3
MEDB 1.10	Ophthalmology Examination	0.25	R/0/1
MEDB 1.14	Photodocumentation of Skin	0.18	R/0/1
MEDB 2.1	Laboratory Testing	0.25	R/0/1
MEDB 4.2	Active Postural Stand Test	0.33	R+0
MEDB 8.1	Nutritional Assessment	0.33	R+0
	Total Time	3.59	

To optimize time commitment, data and samples are shared with mission science. Neurological Assessment, Ophthalmology Examination and Photodocumentation of Skin may be combined with the Clinical Assessment



Medical -Science Scenarios



- **Scenario 1 (Preferred) – 4-hr return to land-based BDCF via helicopter**
 - Modeled after Shuttle and Soyuz landings
 - Ship-Board Medical Operations Team
 - 2 Flight Surgeons
 - 2 Nurses
 - 0.5 Clinical Lab Med Tech
 - Ship-Board Science Research Team
 - 0.5 Clinical Lab Med Tech
 - 1 Sample Return/Biomedical Test Specialist
 - 2 Science Investigators



- Enables greater capability to perform medical care and mission science to meet Agency/Program objectives
- Requires a helicopter and potential other infrastructure/ship crew



Medical -Science Scenarios



Scenario 2 – 24-hr return to land-based BDCE via ship

Ship-Board Medical Operations Team

2 Flight Surgeons

2 Nurses

1 Clinical Lab Med Tech

1 ASCR

Ship-Board Science Research Team

1 Clinical Lab Med Tech

1 Sample Return/Biomedical Test Specialist

5 Science Investigators

**Science personnel support
may vary depending on
R+0 science requirements**

- **Delay in access to flight crew would affect science objectives due to prolonged re-adaptation to 1G**
- **Limits neurovestibular testing due to ship's motion**
- **Limits science operations due to restricted space for equipment and personnel**
- **Movement of crewmembers may require elevator access (crewmembers may be supine)**
- **Additional logistical support for ship-board personnel required**



Crew Sample Landing Day Schedule



Scenario 1 (Preferred) – 4-hr return to land-based BDCF via helicopter

Beginning upon arrival to Ship: 00:00

CREW	0:30	1 hr	1:30	2 hrs	2.5 hrs	3 hrs	3.5 hrs	4 hrs	4.5 hrs
Astro 1	MEDICAL EXAM	ULTRASOUND	BLOOD DRAW NOTES 1 & 2 Vitals	Actiwatch Sleep Log ECG AT REST	Helicopter Return to Baseline Data Collection Facility			Postflight Science and Crew Rehabilitation	
Astro 2	ULTRASOUND	MEDICAL EXAM	ECG AT REST BLOOD DRAW	Notes 1 & 2 Vitals Actiwatch Sleep Log	Helicopter Return to Baseline Data Collection Facility			Postflight Science and Crew Rehabilitation	
Astro 3	MEDICAL EXAM	BLOOD DRAW ECG AT REST	ULTRASOUND	Notes 1 & 2 Vitals Actiwatch Sleep Log	Helicopter Return to Baseline Data Collection Facility			Postflight Science and Crew Rehabilitation	
Astro 4	ECG AT REST BLOOD DRAW	MEDICAL EXAM	NOTES 1 & 2 Vitals Actiwatch Sleep Log	ULTRASOUND	Helicopter Return to Baseline Data Collection Facility			Postflight Science and Crew Rehabilitation	





Crew Sample Landing Day Schedule



Scenario 2 – 24-hr return to land-based BDCF via ship

Requires additional science personnel support

Beginning upon arrival to Ship: 00:00

CREW	0:30	1 hr	1:30	2 hrs	2.5 hrs	3 hrs	3.5 hrs	4 hrs	4.5 hrs
Astro 1	MEDICAL EXAM	Muscle Biopsy	BLOOD DRAW NOTES 1 & 2 Vitals	Actiwatch Sleep Log ECG AT REST	Cognitive Performance	Operational Tilt	ULTRASOUND	Crew Rehabilitation	
Astro 2	ULTRASOUND	MEDICAL EXAM	ECG AT REST BLOOD DRAW	Operational Tilt	Notes 1 & 2 Vitals Actiwatch Sleep Log	Muscle Biopsy	Cognitive Performance	Crew Rehabilitation	
Astro 3	MEDICAL EXAM	BLOOD DRAW ECG AT REST	ULTRASOUND	Notes 1 & 2 Vitals Actiwatch Sleep Log	Operational Tilt	Cognitive Performance	Muscle Biopsy	Crew Rehabilitation	
Astro 4	ECG AT REST BLOOD DRAW	MEDICAL EXAM	NOTES 1 & 2 Vitals Actiwatch Sleep Log	Cognitive Performance	Muscle Biopsy	ULTRASOUND	Operational Tilt	Crew Rehabilitation	





Integration of Medical and Science Operations

Some data and/or samples collected during ISS missions are shared between Space Medicine and research investigations (Informed Consent)

R+0 Day

Sleep Logs and Actiwatch

Reaction Self Test

Urinalysis (24/48 hr)

Ultrasound Imaging

Clinical blood analysis

Medication Log

Heart Rate and Blood Pressure

Food Frequency Questionnaire

Health Status Evaluation

Orthostatic tolerance test

Height and Body Weight

Graded Exercise Test Cycle

Ergometry

Isokinetic Test

Metabolic Cost

Functional Task Test

Exercise Logs (duration, intensity, & modality)

DEXA

Rehabilitation record

**INTERDISCIPLINARY DATA/SAMPLE SHARING MINIMIZES RISKS ,
INCONVENIENCES AND TIME TO CREWMEMBERS**



Helicopter and Helipad Requirements



- **Helicopter**
 - **On 8 Oct 08, the JSC Medical Operation Branch (MOB) consensus was that helicopter support is required to take injured or medically challenged crew member(s) to the nearest hospital facility**
 - **On 9 Oct 08, the Space Medicine Division Configuration Control Board (SMCCB) concurred with this position**
- **Helipad**
 - **JSC Medical considers the use of a helipad as the primary means of loading crewmembers onto a helicopter on the ship**
 - **It is much safer and faster to load ill/injured crewmembers and care providers at a helipad than to do a hoist operation**
 - **A helipad would keep the helicopter out of the red (danger) area on the Height - Velocity diagram (helicopter diagram in b/u charts)**
 - **A vote by the L&RWG on whether to have the helipad did not produce a consensus, but the majority favored having the helipad as a requirement**
 - **During the L&RWG meeting on 10 Aug, it was confirmed that CB supported this position**



Medical Support



- **All astronauts returning from long-duration (≥ 30 days) space flight have neurovestibular and cardiovascular disturbances due to re-adaptation to gravity that requires supportive care**
 - **Based on long-duration space flight experience to date**
 - **A majority will require treatment including IV fluids and parenteral medications to control their symptoms even at nominal end of mission**
 - **To support a crew of four individuals, a team of two NASA flight surgeons, two registered nurses, and a clinical laboratory medical technician is required.**
- **For postflight contingencies requiring crew evacuation:**
 - **Members of the medical team will accompany each crewmember or groups of crewmembers**
 - **To the maximum extent possible, injured or ill crewmember will be attended by at least one physician or nurse to support them during the contingency**
 - **If medical evacuation of a crewmember(s) is required, and space is available, a crew surgeon will accompany the injured or ill crewmember on the medevac**



Medical Support



- **These team members may not be nominally substituted with other specialists or dual tasked with nonmedical responsibilities**
 - **– Nurses could perform blood draws for medical and science experiments as long as there are no conflicts with their primary responsibility for crew medical care**
 - **• However, the blood analysis and sample postprocessing would require them to leave the crewmember and would violate protocol.**



Open Issues

- **Current proposed plan does not address:**
 - **IP support for medical and science operations**
 - **International Flight Surgeons assigned to IP crewmembers**
 - **Multinational crewmembers participating in agency sponsored science**
 - **VIP attendance including**
 - **NASA HQ management**
 - **Flight Director**
 - **Program Management**



NASA Space Life Sciences Recommendation



Based on both the Medical Operations and Science Research requirements, our recommendation is to support Scenario 1 and the return of the crewmembers to a land – based BDCF within 4 hours of crew return to the ship.

Mission science personnel should be categorized as “Mission Critical”

